Current imaging of childhood urinary tract infection

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Introduction

Childhood urinary tract infection (UTI) is common, affecting 8% of girls and 2% of boys by the age of eight years. In this article, we aim to review the current guidelines of the UK National Institute for Health and Care Excellence (NICE) (2007) and the American Academy of Pediatrics (AAP) (2011), for the management of childhood UTI.

In 1991, the Royal College of Physicians proposed consensus guidelines for the management of childhood UTI, which recommended ultrasonography, cystography and dimercaptosuccinic acid (DMSA) scanning for almost every child following a first UTI. However, new evidence accumulated over the past two decades suggests that much less imaging is necessary.

Several medical advances have contributed to this revised thinking:

1. Since the early 1990s, widespread uptake of antenatal screening sonography has contributed to earlier diagnosis of congenital urinary tract abnormalities which, in the past, were usually presented with childhood UTI.

2. The causal association between vesicoureteral reflux (VUR), with or without UTI, and renal scarring has been questioned.

3. Evidence now suggests that most renal scarring does not lead to long-term complications such as hypertension, hypertensive disease of pregnancy, chronic renal failure and end-stage renal failure.

Only two per cent of children with renal failure give a history of UTI. The Randomized Intervention for Children with Vesicoureteral Reflux (RIVUR) Trial, currently in progress in the USA, is attempting to definitively clarify whether antibiotic prophylaxis prevents UTI recurrence and renal scarring in children with VUR.

Current imaging guidelines (NICE and AAP)

For the reasons outlined above, both NICE and AAP suggest less imaging following a first UTI in children. Both NICE and AAP target children with no underlying complicating pathologies, presenting de novo to their general practitioners or hospital emergency departments. NICE refers to the 0-16 year age group, and AAP to the two to 24 month age group. The AAP guidelines do not refer to babies aged less than two months (neonatal UTI), where a more aggressive imaging approach is suggested.

NICE guidance specifies that the following categories of children fall outside the remit of its recommendations:

- Catheterised children
- Children with neurogenic bladders
- Children with known significant uropathies
- Children with underlying renal disease (eg nephrotic syndrome)
- Immunocompromised children
- Infants and children in intensive care units
- Preventive measures or long-term management of sexually active girls with recurrent UTI.

Recommendations for imaging in the UK (NICE)

The Royal College of Radiologists recommends imaging according to NICE guidelines and this is summarised in the paediatric referral guidelines of the RCR’s iRefer: Making the best use of clinical radiology. Both NICE and AAP outline a risk stratification model for imaging UTI (table 1). NICE categorises UTIs into those that respond to treatment within 48 hours, atypical infections and recurrent UTIs (figure 1). The imaging recommendations of NICE for these categories in different age groups are outlined in tables 2a, 2b and 2c.

Recommendations for imaging of the AAP

AAP recommends that febrile infants with UTI should undergo renal tract ultrasonography (US) to exclude anatomic abnormalities that may require further assessment: that is, additional imaging or urology consultation. Sonography evaluates the renal parenchyma and assesses renal size, and can be used to monitor renal growth. The timing of renal US depends on the clinical situation. US is recommended during the first two days of treatment to identify serious complications (eg renal or perirenal abscesses or pyonephrosis associated with obstructive uropathy) when the clinical illness is severe or there is lack of substantial clinical improvement within 48 hours.

The AAP recommends that micturating cystourethrogram (MCUG) should not be performed routinely after the first febrile UTI in infants 2-24 months of age. MCUG is indicated if US reveals hydronephrosis, scarring, or other findings suggestive of high grade VUR. According to AAP guidelines, the role of DMSA scanning is confined to research.

Diagnosis and treatment of urinary tract infection

Diagnosis of UTI may prove quite challenging, particularly in very young and preverbal infants. Both NICE and AAP make recommendations as to the best methods of urine collection for analysis. Both guidelines consider dipstick analysis of urine, looking for leucocyte esterase and nitrites, and urine microscopy looking for organisms and pyuria to be very useful for immediate diagnosis of possible UTI, prior to starting antibiotics. The gold standard for diagnosis, in both guidelines is urine culture and sensitivity of adequately collected urine samples.

The majority of children with uncomplicated UTI may be managed in the community with oral antibiotics for seven to 10 days. Referral to specialist paediatric care is recommended in infants younger than three months of age, and older children who are not responding to oral antibiotics within 48 hours. The aim of antibiotic therapy is to treat symptoms and minimise the development of any renal parenchymal defects.

Neither NICE nor AAP recommends routine antibiotic prophylaxis after uncomplicated UTI. Both guidelines recommend that antibacterial prophylaxis is restricted to prescription on a case-by-case basis by paediatric (medical and urological) specialists.
Conclusion
In this review, we aimed to summarise current recommendations for the diagnosis, imaging and treatment of childhood UTI. Recent evidence-based guidelines for the management of childhood UTI, on both sides of the Atlantic, recommend less imaging and less aggressive antibiotic treatment in uncomplicated UTI, than was advocated two decades ago.

Learning points
Both NICE 2007 and AAP 2011:
- Endorse urinary tract ultrasonography as first-line and main imaging assessment modality;
- Do not advocate routine antibiotic prophylaxis in children with no underlying pathology;
- Highlight importance of educating parents/carers with reference to vigilance for, and prompt treatment of, recurrent UTI.

References

Table 1
Comparison of risk factors for childhood UTI.

<table>
<thead>
<tr>
<th>Diagnostic approach</th>
<th>NICE 2007</th>
<th>AAP 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognising risk factors/assessing likelihood of UTI</td>
<td>• History suggesting or previous confirmed UTI</td>
<td>Risk factors in girls:</td>
</tr>
<tr>
<td></td>
<td>• Recurrent PUO</td>
<td>• white race</td>
</tr>
<tr>
<td></td>
<td>• Antenatally diagnosed renal abnormality</td>
<td>• age &lt;12 months</td>
</tr>
<tr>
<td></td>
<td>• Family history of VUR or renal disease</td>
<td>• temp &gt;39°C</td>
</tr>
<tr>
<td></td>
<td>• Constipation</td>
<td>• fever ≥2 days</td>
</tr>
<tr>
<td></td>
<td>• Dysfunctional voiding</td>
<td>• absence of other source of infection</td>
</tr>
<tr>
<td></td>
<td>• Uncircumcised males</td>
<td>Risk factors in boys:</td>
</tr>
<tr>
<td></td>
<td>• Enlarged urinary bladder</td>
<td>• uncircumcised males</td>
</tr>
<tr>
<td></td>
<td>• Abdominal mass</td>
<td>• non-black race</td>
</tr>
<tr>
<td></td>
<td>• Evidence of spinal lesion</td>
<td>• temp ≥39°C</td>
</tr>
<tr>
<td></td>
<td>• Poor growth</td>
<td>• fever &gt;24h</td>
</tr>
<tr>
<td></td>
<td>• High blood pressure</td>
<td>• absence of another source of infection</td>
</tr>
</tbody>
</table>

Table 2a
Imaging schedule for infants younger than six months (NICE 2007).
If abnormal consider MCUG.
If an infant or child with a non-coliform UTI is responding well to antibiotics and has no other features of atypical infection, the US can be requested on a non-urgent basis to take place within six weeks.

<table>
<thead>
<tr>
<th>Test</th>
<th>Responds well to treatment within 48h</th>
<th>Atypical UTI</th>
<th>Recurrent UTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>US during acute infection</td>
<td>No</td>
<td>Yesb</td>
<td>Yes</td>
</tr>
<tr>
<td>US within six weeks</td>
<td>Yesa</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>DMSA in four to six months</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MCUG</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 2b
Imaging schedule for infants and children six months or older but younger than three years (NICE 2007).
If an infant or child with a non-coliform UTI is responding well to antibiotics and has no other features of atypical infection, the US can be requested on a non-urgent basis to take place within six weeks.
MCUG should be considered if the following features are present: dilatation on US, poor urine flow, non-coliform infection, family history of VUR.

<table>
<thead>
<tr>
<th>Test</th>
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<th>Atypical UTI</th>
<th>Recurrent UTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>US during acute infection</td>
<td>No</td>
<td>Yesb</td>
<td>No</td>
</tr>
<tr>
<td>US within six weeks</td>
<td>No</td>
<td>No</td>
<td>Yesb</td>
</tr>
<tr>
<td>DMSA in four to six months</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>MCUG</td>
<td>No</td>
<td>No</td>
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</tbody>
</table>

Table 2c
Imaging schedule for children three years and older (NICE 2007).
If an infant or child with a non-coliform UTI is responding well to antibiotics and has no other features of atypical infection, the US can be requested on a non-urgent basis to take place within six weeks.
MCUG should be considered if the following features are present: dilatation on US, poor urine flow, non-coliform infection, family history of VUR.

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<th>Atypical UTI</th>
<th>Recurrent UTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>US during acute infection</td>
<td>No</td>
<td>Yesb</td>
<td>No</td>
</tr>
<tr>
<td>US within six weeks</td>
<td>No</td>
<td>No</td>
<td>Yesb</td>
</tr>
<tr>
<td>DMSA in four to six months</td>
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<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>MCUG</td>
<td>No</td>
<td>No</td>
<td>No</td>
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</table>
**Atypical UTI includes:**
- Seriously ill (NICE clinical guideline 54)
- Poor urine flow
- Abdominal or bladder mass
- Raised creatinine
- Septicaemia
- Failure to respond to treatment with suitable antibiotics within 48 hours
- Infection with non-coliform bacteria.

**Recurrent UTI is defined as:**
- Two or more episodes of UTI with pyelonephritis/upper tract infection, or
- One episode of UTI with pyelonephritis/upper urinary tract infection plus one or more episode of UTI with cystitis/lower urinary tract infection, or
- Three or more episodes of UTI with cystitis/lower tract infection.

**Figure 1**
Definitions of atypical and recurrent UTIs according to NICE.

**Figure 2A**
Normal two-month-old.

**Figure 2B**
Normal five-year-old.

**Figure 2A and B**
Normal kidney ultrasound. There is much less central sinus fat than in adults. The papillae are seen as echopoor pyramids in neonates (arrows). Not to be confused with pelvicalyceal dilatation.

**Figure 3**
Pelvicalyceal dilatation in a neonate – ultrasound image. This was an antenatal diagnosis. There was no UTI. Grade 5 VUR seen on subsequent MCUG.

**Figure 4**
MCUG: Bilateral vesicoureteric reflux. Right grade 5, left grade 2/3.
Figure 5
DMSA: normal left kidney (88% function), scarred right kidney (12% function).